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DRAFT REPORT ON A CONCEPTUAL FRAME WORK FOR ENVIRONMENTALLY SOUND AND APPROPRIATE TECHNOLOGIES

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UNITED NATIONS ENVIRONMENT PROGRAMME

DRAFT REPORT 1/
ON
A CONCEPTUAL FRAMEWORK FOR ENVIRONMENTALLY SOUND AND APPROPRIATE TECHNOLOGIES

1. INTRODUCTION

1.1 The Governing Council of the United Nations Environment Programme, at its third session (Nairobi, April/May 1975) requested 2/ the Executive Director "... to initiate as soon as possible programme activities on environmentally sound and appropriate technologies".

1.2 Accordingly, the United Nations Environment Programme has initiated an internal project on "Environmentally Sound and Appropriate Technologies". 3/

1.3 It has been planned that this project will be implemented in several phases, and that the first phase will be concerned with the evolution of a conceptual framework for environmentally sound and appropriate technologies. The subsequent phases will involve the generation of a methodology for the development and diffusion of these technologies, followed by the establishment of a network of pilot projects.

1.4 To facilitate the elaboration of the conceptual framework, an Expert Group Meeting was convened from 1-4 December 1975 at Nairobi, and what follows is based on the proceedings of that meeting.

1.5 In so far as technology is a crucial factor determining man's intervention in the processes of the biosphere and his drive to achieve socio-economic objectives, it has an explicit or implicit place in all environmental and socio-economic considerations. This report must, therefore, be seen as part of a number of studies by the United Nations Environment Programme and other United Nations agencies on environmental and socio-economic subjects related to technology.

1.6 In one respect, however, this report strikes a point of departure. It is often - but not always - believed that the only brand of technology to be considered is that currently in vogue in the advanced, industrialized countries. This report, however, considers that the effects of technology upon the environment and society are not only determined by the type of technology that is utilized, but in as significant a way, by the choice of technology. Invariably, there are several possible starting materials, several ways of utilizing resources, and several possible products to fulfil the same or similar functions, and each of these ways,

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1/ This is the report of the Expert Group Meeting held at Nairobi, 1-4 December 1975. The views expressed here are not necessarily the views of UNEP.

2/ UNEP/GC/55,29 (III) 9 (b).

3/ UNEP Internal Project FP/0402-75-02 (826).

i.e., technologies, has built-in environmental and social effects. In such situations, the effect on the environment and on society is an inevitable consequence of the particular choice of technology that is made. Thus, the criteria set up for the choice of technology are a crucial mechanism for introducing concern for the environment and for society.

This line of thinking has resulted in a significant volume of opinion in both developing and developed countries that there are technological options other than those which have been implemented in the developed countries, and that a quest for alternative options leads to a new pattern of technologies which can be both environmentally sound and socio-economically appropriate.

I.7 It is these environmentally sound and appropriate technologies that constitute the central theme of this report which consists of nine parts.

The next part is concerned with a summary of the criticisms which have been voiced against the technology extensively deployed in the developed countries and indiscriminately adopted as the basis of industrialization in the developing countries. Since the criticisms from the contexts of the developed and developing world have emerged as two separate and unrelated streams of thought, the main task is to search for common bases, and to attempt an ordering of the seemingly unrelated criticisms into coherent structures which can be enmeshed into a hopefully universal viewpoint.

The intention of recording these criticisms is to use them as an introduction to the third part of the report. This deals with the terminological questions arising from the apparently unending proliferation of new terms to designate the proposed or desired patterns of technologies. The aim of the exercise is to seek and understanding of the connotations of the various terms, and to show that they are all directed to a mix of three goals - an environmental goal, an economic goal and a social goal. The various terms will be seen to differ in the emphasis accorded to each of these three goals in the final blend of concerns. Avoiding the semantic trap of either trying to decide upon the best (?) term or attempting "correct" definitions, it will be shown that the three environmental, economic and social goals, which are the preoccupation of the various terms, are all included in the term "environmentally sound and appropriate technologies".

The fourth part of the report attempts an elucidation of the concept of "environmentally sound and appropriate technologies". Such an elucidation becomes essential because the term "appropriate" acquires content only in relation to precisely defined socio-economic goals which must necessarily differ in the widely different contexts of developing and developed countries. What would appear a hopeless task of defining goals which will be widely agreed upon is facilitated by the acceptance within the United Nations system of the goal of a New International Economic Order and the goal of development. It is these two goals which permit the generation of criteria for socio-economic appropriateness for both developed and developing countries.

The next four parts of the report then go on to an examination of the environmental, economic, social and scientific implications of the extensive adoption of an alternative pattern of technologies in developed and developing countries.

The concluding, and ninth part of the report highlights some of the further questions which require elucidation in a subsequent study.

2. CRITICISMS OF MODERN TECHNOLOGY

2.1 Over the past few years, the case for alternative or appropriate technologies has been repeatedly stated in different ways and from various standpoints. This quest for alternatives has invariably been based on implicit or explicit criticisms of the pattern of technologies now current in the industrialized, developed countries and in the process of transfer to the developing countries. These are the technologies which have developed with staggering and increasing rapidity particularly over the past thirty years.

2.2 Since these technologies will necessarily have to be referred to very frequently throughout the course of this report, it will facilitate exposition to refer to them with the term modern. Other terms have also been used in the literature, for example, "western" and "conventional". But, the term "western" ignores the fact that some eastern countries are involved as heavily in the development, use and transfer of "modern technologies"; and the term "conventional technologies", which connotes the widespread belief that the technology of the developed world is the only acceptable brand, is liable to be confused with "traditional technologies" which are in fact being displaced throughout the developing countries by the modern technologies characteristic of the industrialized countries. On the other hand, the unsatisfactory feature of the term "modern technologies" is that it may suggest that the proposed or desired alternative technologies (which constitute the subject matter of this report) are the antithesis of modern in the sense that they do not take advantage of the heritage of accumulated knowledge and that they are bereft of the theoretical and experimental power of modern science. In fact, however, it is intended that alternative technologies are developed by as modern and sophisticated a methodology as the "modern" technologies of the developed countries. Thus, it is only for want of a better term that the technology of the developed world will be referred to as "modern technology".

2.3 The mounting criticisms of modern technology which have emerged, not only from the developing countries, but as strongly from the developed countries, constitute the basis for the recommendation of an alternative pattern of technologies. Hence, a description of these criticisms must serve as an introduction to the concept of appropriate technologies.

2.4 The various criticisms of modern technology can be classified into three broad categories: (1) Environmental; (2) Economic; and (3) Social; but the overlap between these categories prevents an unambiguous classification. Further, it is often difficult to establish the precise

extent to which modern technology is the sole causal factor responsible for the effects eliciting the criticisms, and the extent wo which the overall social structure in which technology operates is in fact the crucial factor. But, such difficulties are inevitable when two systems, for example, technology and society, are closely interrelated, strongly interacting and dynamically involved. Thus, in many respects, the classification of criticisms is essentially indicative.

2.5 Developed countries

2.5 (a) Environmental criticisms

The prolific advances of modern technology in the developed countries have led to spectacular increases in affluence, but it has been asserted that this affluence has not necessarily resulted in an environment more conducive to the physical and mental well-being of man. Indeed, with the increasing deployment of modern technology, man's welfare has been threatened by escalating levels of pollution - pollution of the air that he breathes, the water that he drinks, the food that he eats, the quietness that he needs (instead of "the decibel inferno") and the beauty of nature that he enjoys. This saga of progress in technology being associated with deterioration of the environment has been too well documented to need repetition here. It suffices to quote from the series Man's Home: 4/ "The industries that pollute the most tend to grow rapidly,... New production technologies that pollute more tend to replace older, cleaner production methods".

At the same time, the nature of these technologies (their scale, their demands on energy, water, etc.) has a determining influence on the structure and functioning of human settlements. In particular, urban gigantism has become increasingly predominant; and with it, has followed the aggravation of psychological stresses and social tensions, until many a famous metropolis has been left with a decaying core of slums, crime and insecurity. Simultaneously, these giant cities have had major environmental impacts arising from their exorbitant demands for water, energy, sanitation, transportation and housing.

All this hyper-activity of production and consumption has involved a scale of "exploitation of natural resources" - the telling phrase used in common parlance - unprecedented in human history. The word "exploitation", which accurately describes the essence of the man-nature relationship implicit in modern technology, connotes the very opposite of efficient resource management. No wonder there is alarm at the rapid rate with which non-renewable resources are being depleted. The story can be and has been illustrated with innumerable examples, for example, petroleum and minerals. This mismanagement, which it is argued is an inherent feature of modern technology, extends even to the renewable resources

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4/ "Man's Home", prepared with the co-operation of the Secretariat of the United Nations Conference on the Human Environment, Stockholm, 1972, "Pollutants: Poisons around the World", page 19.

of air, water and land. In short, modern technology has been criticised because it is based on the assumption that nature is an inexhaustible source for the satisfaction of man's escalating resource needs and a limitless sink for his wastes. Modern technologies do not explicitly concern themselves with "the full and heavy responsibility of managing all the resources - human and natural - of this planet". 5/

The effects of this irresponsibility are already evident in the disturbance of the finely adjusted ecological balances of nature through pollution, reckless use of resources, elimination or near elimination of various species (blue whales, for instance), destruction of forests, etc. The question is not one of the intrinsic value of stability in ecosystems, but of the inevitably engendered risks that modern technology brings in its wake. These risks derive from the fact that the effects of these technologies are invariably multiple, often uncontrolled and rarely predictable and foreseen. Further, the gravity of the risks vary from relatively trivial ones like automobile accidents to potentially catastrophic ones such as all-out nuclear warfare or destruction of the life-sustaining properties of the biosphere. Some of these risks may be cumulative like the build-up of nuclear wastes or of optically active pollutants in the atmosphere, or they may be discrete risks like genetic engineering accidents.

In the absence of detailed estimates of the probability of the risks, one can only guess at the shape of a schematic risk distribution curve (see Figure 1).

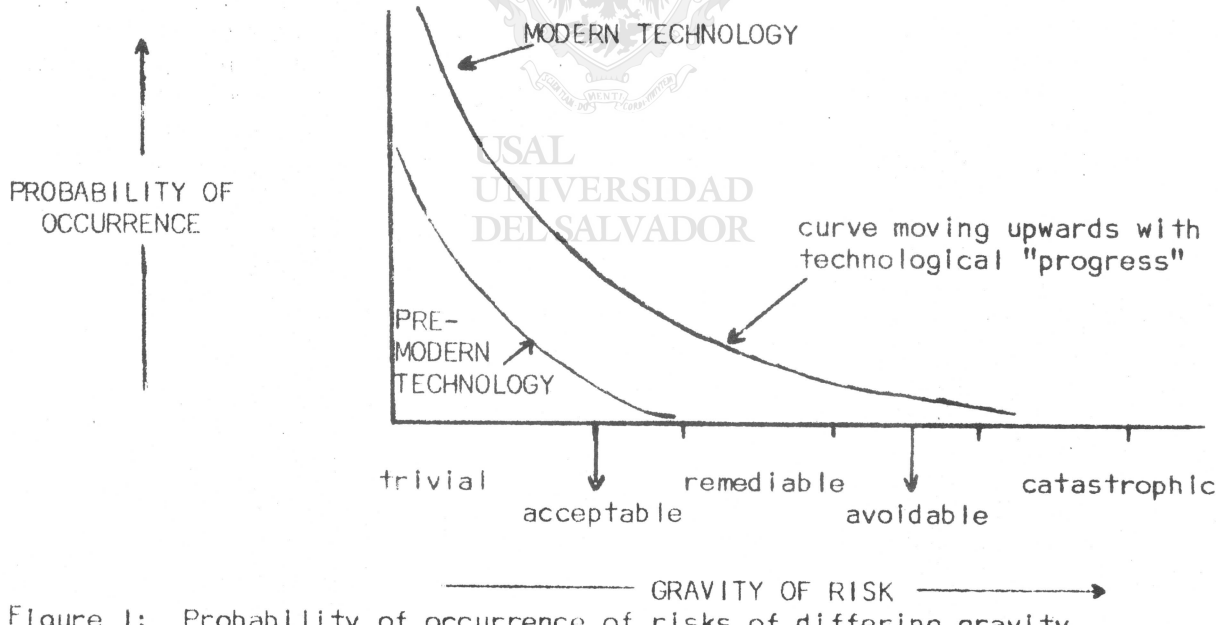

Figure 1: Probability of occurrence of risks of differing gravity

5/ Ibid.

Two comments need to be made about the curve: firstly, "progress" in modern technology tends to move upwards, so that the probable frequency of occurrence of any category of risk will increase in time unless alternative technological options are adopted; and secondly, before the advent of modern technology, there was a virtually zero probability of any risks graver than the acceptable.

According to the critics, these diverse, but deleterious, environmental consequences stem from the following fundamental characteristics of modern technology:

(i) Its pursuit of economics of scale leads to an ever-increasing size of the productive units; and this obsession with large-scale production results in a constantly increasing magnitude of perturbation of natural ecosystems through the spatial localization of pollutant sources and the temporal increase of the rate of emission and discharge of these pollutants;

(ii) These gigantic productive units are highly interdependent by way of inputs and outputs, and they also place stringent demands on infrastructures; hence, these units must be agglomerated into small areas of intense industrialization, and thus compel the concentration of millions of working people into crowded metropolises which then display the well-known environmental problems of excessively large human settlements;

(iii) The constant urge to satisfy the needs of individual consumption and sustain the large productive units results in a continuous drive to develop and distribute luxury products, which are ever changing in appearance and form, but essentially similar in function and content; and this obsession with product technology is the root cause of the rape and exhaustion of resources, the high degree of product obsolescence and the throw-away philosophy;

(iv) The major role of military objectives in determining the development of technology has resulted in the arsenals of many developed countries being filled with weapons so terrible that, if used, all life on earth can be destroyed;

(v) Its growing energy-intensiveness leads, on the one hand, to centralized energy production with an increasing environmental impact, and on the other hand, to a reckless profligacy in the use of energy sources, particularly fossil fuels.

2.5 (b) Economic criticisms

From the economic point of view, the major criticism of modern technology is that it tends to magnify inequalites between countries, and within countries (including developed ones!). Thus, it plays a crucial role in making inequality recursive and increase with time.

The contention underlying this criticism is that an inequality in the distribution of purchasing power leads to a skewed *demand* structure, which in turn influences technology to respond mere avidly to the needs of the rich whilst assigning lower priority to the needs of those who exert weaker demand. The result is the emergence of technologies of products, technologies of production and technologies of resource use which are more responsive and accessible to the privileged than to the underprivileged. And thus, one comes to the next turn of the spiral ... the increased inequality resulting from the initially unequal access to the new technologies stimulates the development of further advances in technology which will then accentuate the inequalities even more.

Technology has perhaps always played this divisive role, but in the past the low levels of capital and energy intensity characteristic of primitive technology facilitated virtually equal access. In contrast, modern technology associated as it is with its high capital and energy intensity, tends to be intrinsically incompatible with equality of access.

This inequality-magnifying effect of modern technology has become particularly evident in the relationship between developed and developing countries, which has its historical roots in the era of the exploitative domination by imperial powers over colonies. Today, modern technology has become the principal instrument for widening the disparities between these two sets of countries and for exacerbating their relationship into an irrational and unjust economic order. This economic order involves a "world market system ... (which) ... has continually operated to increase the power and wealth of the rich (countries) and maintain the relative deprivation of the poor (countries)", according to the Cocoyoc Declaration. 6/ And, in this world market system, those who control modern technology acquire the power to dictate prices. Thus, the volume of experts by the poor world increased by one-third over the past 20 years, yet the value of these exports increased by only 4 per cent.

Further, the development and control of modern technology today is largely in the hands of the multinational corporations, which originate and often represent the developed countries, but are increasingly taking a stance of profit-motivated, self-interested independence with respect to their countries of origin. The necessity of bridling these multinational corporations and redressing the inequality and injustice in the relationship between developed and developing countries has led the poor nations of the world to demand the establishment of a New International Economic Order, 7/ but this demand has not yet exposed the umbilical link between the current economic order and modern technology.

It is not as if modern technology has not had its tell-tale inequality-magnifying effect within the developed countries too. It has been argued 8/ that almost every developed country has its own poor (these may be racial minorities, or immigrant workers or inhabitants of a backward region), and the disparities between the rich and the poor

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6/ UNEP/UNCTAD Symposium, Cocoyoc, Mexico, 1974.

7/ Resolutions /3200 (S-VI) - 3202 (S-VI)/ adopted by United Nations General Assembly during its Sixth Special Session.

8/ Man's Home Series. "The Art of Progress: Development and the Environment", page 11, "... all developed countries include distinctly underdeveloped geographic areas, social classes, or economic sectors - often underdeveloped in absolute and relative terms.".

in affluent countries are accentuated by modern technologies which tend to cater for the privileged. The underprivileged are thus "left behing to observe vicariously on television how the lucky three-quarters live". 9/ The social effects of this process are another matter which will be discussed below /section 2.5 (c)/.

There are two other criticisms of the economic consequences of modern technology which deserve mention. Firstly, modern technology has been designed to process cheap raw materials, which are mostly imported from the developing countries. It has also been wedded - as pointed out earlier - to economics of scale, and has, therefore, resulted in the gigantism of highly capital - and energy - intensive production units. These units because of their very size cannot adjust to sudden or prolonged cessation in raw material or energy supplies, or for that matter to major escalations in the prices of these supplies. And thus modern technology has conferred upon the industries based on this technology a vulnerability to drastic changes in international trade. For, the same reason, the industries are equally vulnerable to internal disturbances, for example, strikes and sabotage.

Secondly, notwithstanding the apparent economic efficiency of production units based on modern technology, the fact remains that the calculus can be misleading and many costs are ignored even though they are externalized and borne by society or by future generations. For example, a factory may discharge its wastes into a river leaving a township downstream with the cost of purifying the water; or a mine may reduce the cost of mining by working the richest or most accessible strata, but such a procedure only results in future increases in extraction costs which are not reckoned with in the costing.

The economic criticisms outlined above have reiterated a point which emerged from the environmental criticisms: the trend of modern technology to establish larger and larger production units in the name of "reduced costs" sets off a number of unwelcome consequences. In addition, it appears that the capital - and energy intensiveness of modern technology, and the orientation of its product technology towards luxury goods for private consumption, give it the highly undesirable characteristic of accentuating economic inequalities between and within countries and of increasing disparities between the rich and the poor.

2.5 (c) Social criticisms

The tendency of modern technology to respond to the needs of the rich and to accentuate inequalities has proved a highly divisive and disruptive force in the societies of developed countries. By denying the underprivileged access to its constantly publicized benefits, and at the same time forcing them to live check by jowl with its unpleasant features such as pollution, modern technology aggravates their feelings of being dispossessed. The ensuing social stresses and tensions constitute

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9/ Barbara Ward.

an ideal breeding ground for violence. And when these people are also forced by the technology of transportation and human settlements to concentrate in central slums, the city begins a process of decay which spreads outwards from the core. "The turn of the century could see total disintegration in many of the world's already troubled cities". 10/

To worsen the whole situation, modern production technology has relentlessly pursued the so-called economies of mass production and automation. In doing so, it has generated a highly skewed pattern of demand for skills, in which only a few are required to possess a high degree of intellectual capability and/or manual skills, while only the barest minimum of intelligence and dexterity is expected from the vast majority of the working force. To this majority, "soul destroying, meaningless, mechanical, monotonous, moronic work is an insult to human nature which must necessarily and inevitably produce either escapism or aggression". 11/

The successful exclusion of craftsmanship and creativity from work in factories based on modern technology results in the sharp separation of work from leisure, and facilitates the spread of the technology of automated entertainment, where participants are replaced by spectators.

The picture is not much rosier at the opposite end of the income spectrum. Modern product technology is specifically designed, on the one hand, to respond to, and on the other hand, to deliberately evoke and stimulate, demands from those privileged with purchasing power. The result is the proliferation of luxury goods for individual consumption and the generation of overly consumption-oriented lifestyles. But "Man has a limited capacity to absorb material goods. It does not help us to produce and consume more and more if the result is an ever-increasing need for tranquilizers and mental hospitals". 12/ Another result is the uncritical acceptance and slavish following of oriental entrepreneurs of "peace" and "bliss".

The emphasis on a product technology for individual consumption associated with a production technology in which machines play the dominant role has led - so the critics argue - to alienation of men from each other and from their work. And " ... (thus) you have a different kind of poverty. A poverty of loneliness and being unwanted, a poverty of spirit, and that is the worst disease in the world today". 13/ No wonder that "half the hospital beds in Europe and North America are occupied by mental and psychiatric patients". 14/ "One is bound to conclude that the whole living is not worth the effort and that in the end it can only produce a state of things which no individual will be able to bear". 15/

10/ "Exploding Cities Conference", Oxford, 1974.

11/ E.F. Schumacher, "Small is Beautiful".

12/ UNEP/UNCTAD Symposium, Cocoyoc, Mexico, 1974.

13/ Mother Teresa of Calcutta. Quoted in "Study and Action Pack for World Development".

14/ Erik Damman, "Future in Our Hands".

15/ Sigmund Freud. Quoted in "Study and Action Pack for World Development".

At the same time, there looms in the background the technology-power equation. Nations and groups which control modern technology wield power of a magnitude unparalleled in human history, power which has often been used against majorities and for questionable ends. Further, the spectre of technologies of mass communication, of mass persuasion, of surveillance and of armed coercion have produced visions of "1984" come true. And the intrinsic inequalities in access to technology has inevitably led to disparities in access to power. Thus, modern technology makes the goal of social control over the directions of social change fade into the distance.

The social criticisms of modern technology in the context of the developed countries stem from:

(a) Its capital-intensiveness and its responsiveness to the demands of affluence, which together have a dispossessing effect upon those who cannot back up with purchasing power their desires for its benefits;

(b) Its technologies of housing and transportation, which by tending to be oriented towards wealthy private consumers, concentrate the poor and deprived into urban slums inevitably pushed to the centres of large cities;

(c) The emphasis in modern production technology on mass production and automation, which produce alienation through the rigid routine of work and "leisure";

(d) The unceasing tendency of modern technology to bombard satiated buyers with new products, which leads to the enjoyment of the simple, inexpensive and intangible being devalued and replaced by the consumptio of the elaborate, conspicuous and material, i.e., modern technology gives rise directly to the consumption-obsessed lifestyles which generate profits for the producers, but rarely peace and contentment for the consumers;

(e) The preoccupation with military technology which confers on those who control technology a disproportionate share in the exercise of power - power for the external coercion of recalcitrant countries and the internal control of dissenting groups.

2.6 Developing countries

2.6 (a) Environmental criticisms

One would not expect the environmental effects of modern technology to be as serious in developing countries because these countries are not as heavily industrialized. However, this expectation is not borne out in reality. This is because the industrialization of most developing countries has been based on the import of modern technology, which by being highly capital and energy-intensive gravitates to regions where such capital and energy are best mustered, i.e., the urban metropolises. One

observes, therefore, large concentrations of modern technology in the cities, and in these limited regions the intensity of industrialization can be of the same order as in the developed countries. As a consequence, such urban concentrations of modern technology often have levels of pollution as high as in the developed countries.

In some cases, the levels of pollution are even higher than in the developed countries because not only is there much less lobbying against environmental degradation, but there may in fact be a view that ..." all (debate over) environmental problems may ... be potential threats to ... domestic development" 16/ and that developing countries "must not and will not allow themselves to be distracted from the imperatives of economic development and growth by the illusory dream of an atmosphere free from smoke or a landscape innocent of chimney stacks ...". 17/ Such views bring to mind a century old statement from the then industrializing, now polluted, developed countries: "Smoke is an indication of work .... Therefore, we are proud of our smoke". 18/

The viewpoint that environmental degradation is a necessary and unavoidable stage in development can be criticized on two counts. Firstly, it implies the questionable assumption that development must inescapably follow the path used by the developed countries and involving the deployment of modern technologies; and secondly, it does not reckon with the fact that the poverty-stricken inhabitants of developing countries are more adversely affected by pollution because of their much lower level of nutrition and health. Hence, the under-privileged in poor countries can afford pollution even less than healthier and better nourished people in rich countries.

Further, the far weaker environmental lobbies in the developing countries permit many modern technologies based on the plant or mineral resources of the region to use these resources irrationally and wastefully. Serious environmental effects follow, e.g., rayon factories denuding a whole region of its bamboo forests. Such environmentally unsound irrational and wasteful use of resources can also arise from another effect of the introduction of modern technology in developing countries. This effect stems from the creation of urban markets for rural products coming in the wake of rural impoverishment to upset the ecologically sound traditions of resource management. A revealing example of this process is the way urban markets for charcoal have led (and are leading) to rapid deforestation, soil erosion and desertification, and the manner in which metropolitan demand for cash crops have resulted in taking away land from food crops and using it for cash crops.

16/ Man's Home series. "The Art of Progress: Development and the Environment", page 7.

17/ Ibid, page 8.

18/ Ibid, page 8.

Finally, the introduction of modern technologies into developing countries has also been claimed to be directly responsible, through the well-known sequence of rural impoverishment, mass migration to cities and uncontrolled urbanizations, to festering slums which have become major problems from the human settlements and environmental point of view.

Another environmental effect of modern technology in developing countries is an indirect one. It arises because, as already argued, this pattern of technology accentuates inequalities and thus links together affluence and poverty in a cause-effect relationship. The consequence is the perpetuation of underdevelopment. And the "... environmental ills of the developing countries are rooted primarily in poverty and underdevelopment". 19/ To illustrate: the poorest in the land-ownership scale often exploit their limited land so intensively that they cause soil erosion and deforestation, and their counterparts in the cities establish squatter colonies on the most valuable land in the central areas of big cities.

Criticisms of the environmental consequences of modern technology in developing countries run along lines basically similar to those from the developed countries. However, an extra dimension arises from the role of modern technology /see Section 2.6 (b)/ in impoverishing the countryside. This results, firstly, in setting up the unending exodus to cities which then cannot cope with the resulting environmental problems and, secondly, in upsetting the traditionally sound ways of managing rural land.

2.6 (b) Economic criticisms

The most significant criticism of the establishment of modern technology in a developing country is that it triggers off a chain of consequences, the most direct one being that of shattering the traditional rural industries. As a result many of the traditional occupations in the countryside cease to exist, and vast numbers of people are thrown out of work. The problem is then aggravated by the fact that the urban industries are based on imported modern technology, which by being highly capital-intensive and labour-saving restricts the increase of employment per unit of extra investment. Since unemployment aggravates poverty, and since it is only employment at the higher levels of the capital-intensive modern sector that permits entry into the market for the luxury goods produced by modern industry, the gap between the affluent and the poor increases. Modern technologies of conumption are increasigly energy-intensive, and the inability of the poor to enter the market for commercial energy accentuates disparities. And thus, one observes the well-known phenomenon in the developing countries of inequalities growing with increasing industrilization on the basis of modern technology. Further, rural impoverishment leads to increasing mass migration to the metropolitan centres, there to aggravate the problem of slums and shanty towns which are festering sores of unbelievable poverty frustrating the best intentions of urban planners.

19/ Maurice Strong.

Simultaneously, the traditionally simple and contented ways of life succumb before the onslaught of the consumption-oriented lifestyles stimulated and catered to by modern technology. The demand for a new product-mix gets generated, and this product-mix invariably has a higher import content than the traditional mass-consumption goods which are usually based on local resources. Thus, the balance-of-payments situation of developing countries worsens with increasing industrialization on modern lines. At the same time, the import of modern technology requires payments of technical fees, royalties, services of foreign experts, license fees, etc. And with the continuous advance of modern technology, the payments for the import of technology keep on increasing. With increasing technical dependence, self-reliance is thwarted more and more.

Thus, industrialization on the basis of modern technology has been criticized because it consists of a package-deal involving, on the one hand, increasing income disparities, growing unemployment, rural impoverishment, mass migration to urban slums, and on the other hand, increasing import bills, worsening balance-of-payments crises, increasing technical dependence, decreasing self reliance and frustration of the mission of development.

In the last analysis, this package-deal originates from the fact that capital-intensive, labour-saving modern technology is fundamentally inconsistent with the factor proportions of most developing countries, viz., a shortage of capital and an abundance of manpower. The deal is worsened due to two further features of the technology of developed countries firstly, this technology relies on a global resource-base, rather than on locally available resources, and therefore, a developing country which adopts this technology has necessarily to import many raw materials; secondl the deliberate bias of this technology towards meeting elite demand has the twin effect of accentuating disparities in consumption and increasing imports. In short, the content of the package deal makes modern technology incompatible with development.

It is the realization of these harsh facts that has moved local and national groups in developing and developed countries, and also many international agencies, to urge an alternative strategy of development based on a pattern of technologies different from modern technology.

2.6 (c) Social criticisms

Further criticisms of modern technology arise from the social effects that it produces in developing countries. These criticisms focus on two main processes: (1) The disintegration of established social forms of organization which have been interwoven through centuries of evolution with ancient modes of production; and (2) The generation of a dual society involving urban islands of affluence amidst vast seas of rural poverty.

The disruption of traditional social forms resulting from the drastic changes in modes of production introduced by modern technology has a telling effect on the family (e.g., the trend away from extended families with their type of social security and towards nuclear families), on structures of authority (e.g. the displacement of village elders by literate entrepreneurs), on traditions of village self-reliance (e.g., the strenght of collective self-help giving way to the weakness of dependence on urban-based aid and external development agencies), on social mores (e.g., contentment with one's lot being rejected in favour of acquisitive greed), and so on. It is not suggested here that all was perfect in the ancient social forms, but that usually the good has also been rejected along with the bad and that modernization (customarily equated with westernization) is not necessarily conducive to social harmony and individual peace.

For, the dissolution of the traditional society through the process of modernization is associated with the polarization into a dual society: a society, mainly urban, of the affluent 10-20 per cent of the population, and a society of the underprivileged 80-90 per cent, consisting mainly of the rural poor but also including the urban slum-dwellers. The elite largely controls the political decision-making machinery, with so-called "politics" becoming equivalent to wrangles between various sections of this elite. The market economy, the social services and the educational system are almost wholly dominated by the elite, leaving the poor (in particular the poorest 50 per cent) abject poverty with regard to essential goods, services and knowledge. It has been argued that this polarization is the consequence of all modern technologies for goods or services (e.g., health, transport, education) being accessible only to those with purchasing power, and being, therefore, inherently elitist.

This polarization of the society of a developing country into a dual society with a small, affluent, acquisitive, conspicuously consuming, city-centred elite drawing its ideas, values and life styles from the developed countries, and a large mass of poor people left out of the circle of production and consumption by the lack of employment and purchasing power, is an intrinsically unstable situation. It is fertile soil for alienation, tensions and aggression. The instability is amplified by the constant exposure to the overwhelmingly greater affluence of the elite who practise conspicuously a philosophy which can be summed up thus: "all that is rural is bad, all that is urban is better, and all that is foreign is best". Several obvious questions follow: "Can we rationally suppose that (the poor) will accept a world 'half slave, half free', half plunged in consumptive pleasure, half deprived of the bare decencies of life? Can we hope that the protest of the dispossessed will not erupt into local conflicts and widening unrest?" 20/ If social participation and control over their future cannot assume peaceful forms, it can only lead to explosions of violence.

These potentially explosive social effects of modern technology originate mainly from the incompatibility of modern technology with the factor proportions of a developing country. The exhorbitant demands which these technologies make on scarce capital and energy resources has the inevitable result of developing urban pockets at the expense of the countryside, and it is this unevenness in development which is the causal basis for the polarization into a dual society. At the same time, the absence of an evolutionary link between modern and traditional technologies leads to the destruction of traditional rural industries, and thus to the damage of the fabric of social life. This damage is aggravated by the intrinsic tendency of modern technology to respond to, and stimulate,

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20/ "Only One Earth".

life styles modelled on those prevalent in the developed countries. But, the inherently inequality-magnifying feature of these technologies mean that they can only be accessible to an elite. Thus, modern technology broadc the desire for affluent life styles whilst restricting to a small elite the means of satisfying these stimulated desires, and thereby lays the foundation for alienation and social conflicts.

3. QUESTIONS OF TERMINOLOGY

3.1 The gathering storm of criticisms of modern technology has resulted in an apparently unending proliferation of new terms to designate the proposed or desired patterns of technologies. Apart from "alternative", "appropriate" and "intermediate" technologies, some of the other adjectival terms in use are "soft", "humane", "liberatory", "rational", "equilibrium", "convivial", "careful", "radical", "inequality-reducing", "people's", "progres "utopian", "environmentally sound" and "low- and non-waste". This affluence of jargon can prove an embarrassment (of terminological riches!), because the various terms differ in the characteristics considered essential to the new technology being proposed as a counter to modern technology; and even more because the set of complete characteristics associated with each term is difficult to identify amidst explicit statements and implicit views to be read between the lines.

3.2 A scrutiny of the various terms shows, however, that most of them fall into three broad classes:

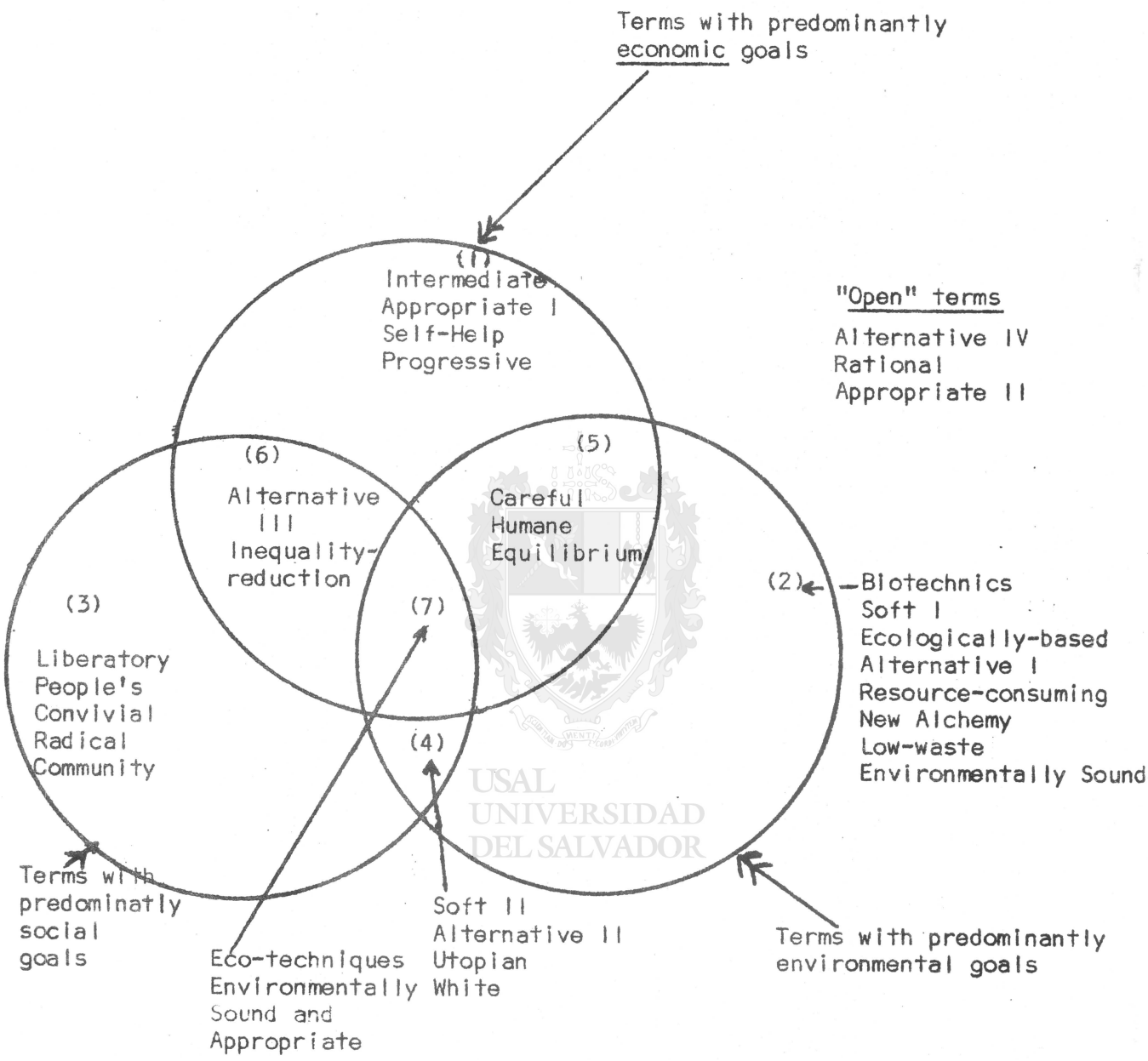
(a) Those in which economic, or more precisely, developmental goals predominate;

(b) Those in which environmental concerns are crucial; and

(c) Those in which social goals are emphasized.

Unfortunately, some of the terms have never been clearly defined; and others may have been defined in one way, but used in another, and understood in yet another way. Further, the intended 'scope' of the various terms is quite different - while some envisage the achievement of fairly limited transitional objectives, others with an utopian grandeur seek to fulfil all conceivable goals and thus "never put a foot wrong".

3.3 More importantly, the three broad classes of goals may partly overlap and partly conflict, and therefore the terms are best laid out in the form of a Venn diagram (Figure 2).



3.4 Terms with predominantly economic goals

3.4.1 Intermediate technology

This type of technology was first proposed by Schumacher in the mid-1960's primarily with the objective of employment-generation in the developing countries.

The quantitative criterion of "intermediate-ness" is taken to be the capital investment required per workplace, which it is suggested should be of the order of $30-300 per workplace in contrast to modern technology's $3,000 per workplace. Intermediate technology also specifies small-scale, decentralized production, rural relevance, use of local materials, and simplicity of operation and maintenance, and ease of fabrication and construction. It has been institutionalized in the form of the Intermediate Technology Development Group, London, and its philosophy has been elaborated extensively in the book Small is Beautiful. 2

Intermediate technology has sometimes been criticized on the grounds that it lays inadequate stress on capital-output ratios and on the developing country having a product-mix compatible with the minimum needs of those below the poverty line.

3.4.2 Appropriate technology I 22/

This term has been used by Indian planners in the early 1960's. 23/ Though, strictly speaking, it has no precise semantic content, it has through usage acquired the same connotation as intermediate technology, i.e., technology which emphasizes smallness of scale, decentralization of production, miserliness in capital investment, labour intensiveness, utilization of local resources. In fact, the journal of the Intermediate Technology Development Group, London, bears the title: "Appropriate Technology". The term appropriate technology is often used in preference to intermediate technology, because it is clear that "intermediateness" alone may not be appropriate for development. In this sense, it is a useful term, because it does not pre-judge what is going to be appropriate in a given case, but it is always considered to be a technology designed for factor proportions fundamentally different from those (factor proportions) to suit which modern technology was developed. And though the term begs the question: "appropriate for what?" it is generally understood to mean appropriate for development, for fulfilling the minimum basic needs of the people, and for rural areas because that is where the bulk of the poor in developing countries live.

3.4.3 Self-help technology

This is a term often used synonymously with intermediate technology, but it stresses the aspect of indigenous development of appropriate technolo rather than the transfer of technology, and the notion of self-reliance rather than dependence on foreign skills, direction and materials. The idea of self-help technology has been used extensively in the writings of Omo-Fadaka 24/ and is a strong element in the expositions of Illich. 25/

21/ E.F. Schumacher, "Small is Beautiful".

22/ The I has been attached to distinguish this use of the term Appropriate Technology from the other uses II and III (see Section 3).

23/ For example,

3.4.4 Progressive technology

This term which has been proposed by Marsden 26/ is virtually identical with Appropriate Technology (II). It includes a number of criteria including the need for the technology to change progressively as capital and skills accumulate, but the technologies should continuously match the stage of development.

3.4.5 The above terms all spring from the notion that economic development is not a uni-dimensional process to be measured by a single simplistic parameter like gross national product or per capita income. Rather, it is a matter of general welfare with many facets, but the distribution of the benefits of technology are far more important than the aggregate rate of growth. The proposed patterns of technology described by the terms: "intermediate", "appropriate", "self-help" and "progressive" arise from the view that modern technology impedes the development process by yielding a skewed distribution of benefits, and that these distortions can be corrected and remedied by the deployment of a judicious combination of traditional technologies, carefully researched and developed modifications of these traditional technologies, and specifically designed appropriate technologies.

The terms described in this section are very close in intention and practice to the terms: Inequality-reduction technologies and Alternative Technology III, of region 6 of the Venn diagram (see Figure 2 and Section 3.9.1).

3.5 Terms with predominantly environmental goals

3.5.1 Biotechnics

This term was first proposed by McKillop and Hogan in a series of pamphlets under the general rubric: "Biotechnic Land-use Publications" in which the key idea was to foster practices consistent with ecological constraints.

3.5.2 Ecologically-based technology

Holliman suggested this term in an unpublished paper prepared for the pre-Stockholm conference in Hamilton, Ontario, in 1971. It was believed that the specification of environmental parameters would be fairly straightforward and would lead to a range of technologies automatically satisfying many other social criteria.

3.5.3 Soft technology I

This term has the obvious implication of "harmless". It was originally conceived in environmental terms by a group in London in 1970, and has been taken up by many other communities. Since then, however, its implications have broadened to include social goals (see Section 3.7.1).

26/

3.5.4 Alternative technology I

McKillop and Harper coined this term for a 1972 London meeting. Initially, it was mainly oriented towards ambient energy sources, but its implications have broadened to incorporate social objectives (see Section 3.7.2). However, it is still widely used in a context of environmental concerns. It is probably the most common term used in the developed countries.

3.5.5 Resource-conserving technology

The connotation of this term is self-evident. It was used by the Alternative technology group at Gothenburg University for a Government-sponsored review project.

3.5.6 New Alchemy

The New Alchemy Institute at Cape Cod, USA, uses this term along with the slogan: "... to protect the lands, restore the seas, and inform the earth's stewards".

3.5.7 The above terms cover roughly the same concerns, and most of them tend to be conceived in connection with a convivial set of devices such as windmills, solar collectors, methane generators, composting toilets, earth walls etc. There was a notion of "simplicity" and a general undercurrent of feeling about "the alternative technology way of life", but, on the whole, there is a preoccupation with gadgets. All the terms imply that social problems would somehow be ameliorated by adoption of the proposed technologies.

3.5.8 Low-waste and non-waste technology

These terms which have been used in the United Nations system refer to technology which does not cause environmental pollution whilst ensuring the most rational utilization of natural resources and energy. Specifically, non-waste technology involves one of the following practices: (a) Purification of industrial discharges; (b) Purification and reprocessing of discharges; (c) In-process waste purification and reprocessing; (d) Recycling of natural resources. Low-waste technology suggests a less ambitious version on non-waste technology. It is clear, however, that these terms imply that modern technology need be questioned only on environmental grounds, and the environmental ills can be remedied by changes in waste-treatment aspects of the production and consumption flow-charts of modern technology. The term does not imply a criticism of either the scale of production of modern technology, or its capital-intensive, labour-saving character, or its product.

3.5.9 Environmentally sound technology

This term can be considered as synonymous with "low-waste and non-waste technology".

3.6 Terms with predominantly social goals

3.6.1 Liberatory technology

This term is part of the title of a seminal but controversial essay: "Towards a Liberatory Technology". The emphasis here is on small-scale community-controlled technologies which would allow maximum freedom for individual expression and foster flexibility to meet local needs. The environmental aspects of technology were not emphasized much in the essay, though its author, Bookchin, was one of the social critics of modern technology to appreciate the significance of ecological variables. These environmental considerations have become more prominent in the subsequent writings of the proponents of liberatory technology.

3.6.2 People's technology

This term was first used by a Swedish group for an exhibition in Stockholm in 1972, and was borrowed from a political banner: "For en teknik i folkets tjanst" (towards a technology to serve the people). The emphasis in this term is on a technology which is operated and controlled directly by users and consumers (rather than by owners/managers of productive units) and directed towards serving their needs. The term became part of the sub-title, viz., "the magazine of radical science and people's technology", of the magazine: Undercurrents. In practice, the term people's technology tended to incorporate environmental criteria and lead to the same kinds of prescriptions for technologies as the terms (see Section 3.5) with predominantly environmental goals.

3.6.3 Convivial technology

This pattern of technology which is described in the writings of Illich implies a technology which will permit a universal condition of "graceful playfulness" (eutrapelia). The technologies must not transcend strict limits of scale or energy use, because large-scale technological systems "force people to consume their products" and erode the ability for free, equal, creative self-reliant activity. Illich has also emphasized that equity can only be guaranteed by technical systems restricted in scale and energy use and by a "voluntary politics of austerity" ("socialism will only come on a bicycle"). It is to be mentioned that though Illich's prescriptions are mainly intended for developing countries, they have only been influential in the developed countries.

3.6.4 Radical technology

This term has been used since 1973 as part of the subtitle of In the Making ("A directory of proposed practical projects in self-management and radical technology"). The intention is of highlighting its social objectives and differentiating itself from pure econaturalism and obsession with alternative gadgetry; but, the detailed implementation turns out much as before, i.e., a preoccupation with back-to-nature moves and with gadgeteering. There is, however, a constant awareness of the role of a new technology in building a new society.

3.6.5 Community technology

Two groups in developed countries have named themselves with this term, both to emphasize their concern with projects appropriate to local needs, and particularly the needs of the underprivileged.

3.7 Terms with equal emphasis on environmental and social goals

3.7.1 Soft technology II

This term is meant to cover the conceptions advanced by Harper and is intended to describe technologies developed to satisfy constraints arising from many different conflicting requirements. The "softness" extends not only to the environment, but also to human beings. Thus, soft technologies are meant to avoid alienation and exploitation. The perspective, however, is rather restricted to developed countries, and the extension to developing countries has undergone some criticism. It is worth noting that the term "Soft technology" has been used by The Whole Earth Epilog to label their section on self-sufficiency technology.

3.7.2 Alternative technology II

This second version of the term Alternative technology derives from a rubric outlined by Harper and Eriksson, proposing a mixture of social and environmental constrainst, judicious use of traditional technologies and direct control by producers and consumers. A similar content has been given to the term by the monograph of Dickson. The distinction between radical approaches to technology, and purely environmental approaches has been emphasized.

3.7.3 Utopian technology

This term has been suggested by Dickson to indicate the general-purpose alternative technology referred to above.

3.7.4 White technology

In the belief that white is the colour of freedom, innocence and peace, the term "White technology" has been used to designate a technology that safeguards those exemplary qualities.

3.8 Terms with equal emphasis on economic and environmental goals

3.8.1 Careful technology

A 1971 conference was held in St. Louis, Missouri, USA, to document a series of environmentally disastrous development projects. The proceedings of the conference were published as a book entitled "Careless Technology", and this title has resulted in the anti-thetical term "careful technology", but the criteria for "carefulness" have yet to be worked out in detail.

3.8.2 Humane technology

This term is used synonymously with "careful technology", and is designed to emphasize the human aspects of environment-development situations. It has been used by environmentalists from the developing countries.

3.8.3 Equilibrium technology

The notion of equilibrium in this term has a many-sided significance - ecological equilibrium (indefinitely sustainable processes), and economic equilibrium between developed and developing countries implying a moving together of the two styles of technology appropriate for developed and developing countries.

3.9 Terms with equal emphasis on economic and social goals

3.9.1 Alternative technology II

This term is used by Indian authors to indicate a pattern of technologies fundamentally different from the patterns prevailing in the developed countries. These alternative technologies are conceived as being the technological basis of alternative development strategies, and as involving 'sophisticated' approaches to low-cost technologies adapted to the needs of the poor. They are also intended to be consistent with the objective of a just and equitable society.

Though environmental considerations have not figured largely in the expositions, the proponents of this pattern of technologies have shown awareness of the importance of these considerations, and most of the proposed criteria (e.g., use of renewable resources) are designed to safeguard the environment.

3.9.2 Inequality-reduction technology

This term includes an explicit criterion for judging the probable developmental effect of a technology. It compels an examination of the consequence of the technology on income distribution and on social equity. The proposed pattern of technologies are based on the premise that development is a process which involves both economic and social objectives consistent with the interests of the poorest sections of the population.

3.10 "Open" terms

3.10.1 Appropriate technology II

This term is used in a neutral way without presupposing any specific value system, it being clearly understood that the appropriateness of a technology must be evaluated in each case with a set of ecological, economic and social criteria.

3.10.2 Rational technology

The rationality or irrationality of a technology is proposed to be arrived after a detailed analysis of true costs, benefits and effectiveness of various technological systems, both conventional and alternative. The term is used by the group in the Architectural Association, London.

3.10.3 Alternative technology IV

This term has been used in a neutral way merely to indicate different styles of technological practice without implying any set of preferences in particular. The quest for alternatives can proceed either at the micro-level, e.g., alternative technologies for the production of a particular commodity, or at the macro-level of a whole package of technologies.

3.11 "Ideal" terms

Region 7 of the Venn diagram (Figure 2) represents a balanced emphasis on environmental, economic and social goals. Some terms are best fitted into this region, for example, Soft technology II and Alternative technology III provided the economic objectives are adjusted to suit the different contexts, e.g., of developed and developing countries. The "open" terms can also be given contents in order to permit their inclusion into region 7.

The term Eco-techniques, coined to indicate the technological component of eco-development, is intended to describe technologies which are in tune with the detailed characteristics of ecosystems whilst facilitating self-reliant and need-oriented development. Thus, the term eco-techniques involves equal concern with environmental, economic and social goals, and should be allocated to region 7. Its use tends to be restricted to developing countries.

4. ENVIRONMENTALLY SOUND AND APPROPRIATE TECHNOLOGIES

4.1 The foregoing discussion reveals a heartening feature. Notwithstanding the many differences of emphasis, priority and strategy, there is 'shifting core' of agreement. There is also a broad domain of accord about many basic assumptions and even about the details of the criteria for the system of technologies proposed as an alternative to modern technologies.

4.2 In particular, it is agreed that technologies must be chosen by taking into account environmental, economic and social goals, though the emphasis may differ in different circumstances. In developed countries, it has been realized that preoccupation with environmental concerns only leads to technological "fixes", i.e., palliatives for the symptoms, rather than cures for the disease; and in developing countries, it has become evident that obsession with per capita GNP and neglect of environmental and social considerations only results in a distortion and frustration of development.

4.3 The obvious objective encompassing environmental, economic and social goals is ecologically balanced growth with economic and social justice, and the technologies consistent with this objective are most conveniently termed environmentally sound and appropriate technologies. In order to be compatible with environmental, economic and social goals, the design and choice of technologies must be guided by the environmental principle of ecological soundness, the economic principle of reduction of inequalities (between countries and within countries) and the social principle of participation and control by the people. The principle of ecological harmony ensures the environmental soundness of the technology, that of inequality reduction, economic appropriateness, and finally, that of participation and control by the people, social appropriateness.

These principles are very much in tune with the three guiding principles contained in the 1975 Dag Hammarskjold Report What Now, viz., harmony with the environment, need 27/ orientation, and endogenous self-reliance.

4.4 There are, of course, no absolute criteria of "appropriateness". This is because "appropriateness", as far as the present discussion is concerned, implies a relationship between technology on the one hand and the social context on the other. Further, it is only for conceptual convenience that one isolates the quality of appropriateness (or inappropriateness) that, rigorously speaking, belongs to the relationship, and confers it on technology even though the latter is interactively and inextricably coupled to the social context. The legitimacy and validity of this conceptual device varies. At one extreme, a technology may be intrinsically appropriate (or inappropriate) for a whole variety of social contexts (e.g., capital-intensive, labour-saving technology is inappropriate for developing countries with grave capital shortages and vast manpower surpluses). At the other extreme, the appropriateness (or inappropriateness) of a particular technology may be decided, not so much by the characteristics of the technology, as by the social institutions and their mode of functioning. An example of this other extreme is an agricultural technology, which may be simple to operate and inexpensive enough to be accessible to the poorest farmers, but may require inputs which can be obtained only through institutions which are biased against the poor. In such a case, the technology will be deemed inappropriate because it is not based on local resources, but the same technology may be deemed appropriate in another context which safeguards and ensures the interests of the underprivileged.

It is clear that, in the latter extreme, it is the social context that is the real barrier, and that without a change in the structure and/or bias of social institutions, technology alone, however appropriate it may be, is not a sufficient condition to promote development. In the former extreme, a change in technology is a necessary condition, however conducive the social context may be for the process of development. In other words, appropriate technology is a necessary, but not sufficient, condition for the achievement of socio-economic objectives. Further, technology has always to be seen in relation to the social setting, and the criteria of appropriateness are necessarily specific to the particular context.

27/ Provided that "needs" are defined in relation to the 'quality of life' which is not necessarily related to the 'quantity of goods'.

4.5 The crucial environmental, economic and social guiding principles of ecological soundness, inequality reduction and people's participation and control have emerged from the criticisms of modern technology and constitute the basis of the proposed alternative patterns of environmentally sound and appropriate technology. It is obvious, however, that in order to give them operational significance and value, they need to be elaborated. This is not a trivial task, but what can conveniently be done here is to propose a series of heuristics, or rules of thumb, or list of preferences to guide the choice of technologies. Looked at in another way, environmentally sound and appropriate technologies are those which have been developed and deployed after a conscious reckoning with the heuristics, thumb-rules and preferences described below in a list. 28/

4.6 Environmental preferences to advance ecological soundness

(1) A preference for energy-production technologies based on renewable, rather than depletable, energy sources (e.g., sun, wind and biogas, rather than oil or coal);

(2) A preference for energy-saving, rather than energy-intensive, technologies;

(3) A preference for technologies which produce goods that can be re-cycled and re-used, rather than used once and thrown away, and that are designed for durability, rather than obsolescence;

(4) A preference for production technologies based on raw materials which are replenishable (e.g., wood and cotton), rather than exhaustible (e.g., steel or petroleum-based synthetic fibres);

(5) A preference for technologies of production and consumption which inherently minimize noxious or dangerous emissions and wastes, rather than those which require 'fixes' to curb their intrinsically polluting tendencies;

(6) A preference for technologies of production and consumption which incorporate waste minimization and utilization procedures as integral components, rather than those which require them as appendages;

(7) A preference for technologies which blend into natural ecosystems by causing them minimal disturbance, rather than those which threaten the biosphere with major perturbations;

(8) A preference for technologies based on the rational sustained use, rather than indiscriminate rapid devastation, of the environment;

(9) A preference for technologies of production (in particular, the aspects of scale and location), of housing and of transporation, which foster the planned achievement of moderately sized, manageable, secure and congenial human settlements, rather than the uncontrolled growth of gigantic, unmanageable, insecure and intolerable cities.

28/ No attempt has been made in the list to avoid either duplication or overlap.

4.7 Economic preferences to reduce inequalities between and within countries

(1) A preference for technologies which are consistent, rather than incompatible, with the basic factor proportions of particular countries, which means, for most developing countries, a preference for energy-conserving, capital-saving and employment-generating, rather than energy-extravagant, capital-intensive and labour-saving, technologies;

(2) A preference for small-scale decentralized, rather then large-scale centralized, technologies;

(3) A preference for need-based, rather than demand-oriented, product technologies;

(4) A preference for the technologies of goods and services relevant to mass consumption, rather than to individual luxuries;

(5) A preference for technologies based on local materials, rather than materials which have to be imported from abroad or trasported from distant parts of the country;

(6) A preference for technologies which generate employment for underprivileged masses, rather than for privileged elites;

(7) A preference for technologies which produce for local consumption, rather than for remote markets;

(8) A preference for technologies which promote a symbiotic and mutually reinforcing, rather than parasitic and destructive, dependence of, on the one hand, the metropolises of developing countries on their rural hinterlands, and on the other hand, of the developed countries on the developing countries;

(9) A preference for technologies which reduce, rather than amplify, the inequalities between countries and within countries.

4.8 Social preferences to increase social participation and control

(1) A preference for technologies which cater to the needs of deprived people, rather than to the demands of the privileged affluent;

(2) A preference for technologies which lead to an enhancement of the quality of life, rather than merely to an increase in the consumption of goods;

(3) A preference for production technologies which require satisfying creative work, rather than boring routine labour, i.e., for technologies which relate men to work, rather than alienate them from it;

(4) A preference for production technologies in which machines are subordinated to, rather than dominate, the lives of people;

(5) A preference for technologies which lead to human settlements being designed to suit the collective and individual lives of people, rather than the requirements of agglomerations of productive units;

(6) A preference for technologies based on communal, rather than individual, use of goods and services;

(7) A preference for technologies which blend with, rather than disrupt, traditional technologies and the fabric of social life;

(8) A preference for the technology of mass producing scaled-down dispersable, miniaturized enterprises, rather than the technology of mass producing consumer goods in gigantic factories;

(9) A preference for technologies developed endogenously from the local context, rather than transferred from alien settings;

(10) A preference for technologies which increase, rather than diminish, the possibility and effectiveness of social participation and control;

(11) A preference for technologies which facilitate the devolution of power to the people, rather than its concentration in the hands of elites.

4.9 Heuristics only assist the endeavour of discovery. Thumb-rules are only starting points; they have to be refined and made precise by deeper analysis. And, preferences only indicate a poise of the intellect and a bias of the emotions; they introduce a value system into the process of judgement. Choices represent the result of that process. Hence, the technologies that are finally chosen are not necessarily those which were preferred - preferences only influence or guide choices, they do not determine them. Between the preference for certain types of patterns of technologies and the final choice of technologies, lies the whole process of decision-making.

4.10 It follows from the above statements that the types and patterns of technologies must be chosen by a conscious process, and that this process always involves value systems in the form of preferences. These preferences are unfortunately not always exposed, revealed and made explicit. Indeed, very often decision-makers are even unaware that technologies have preferences congealed into them and that they embody value-systems (for example, they may reflect a greater reluctance to employ manpower than to spend capital). In fact, it is this oversight 29/ that has led to the view that modern technology is the only type to be considered, that the choice of technology is not a significant issue, and that modern technology does not embody preferences (which are by and large opposite to those listed above).

4.11 Since the conscious or unconscious use of preferences in the process of choosing technology cannot be avoided, and preferences cannot be divorced from value-systems and objectives, it is necessary to state explicitly what value-systems and objectives underlie the preferences enunciated in this report. The environmental and social preferences listed in Sections 4.6 and 4.8 are based on the value-judgements that the environment is the precious habitat for man and that, in the ultimate analysis, all men must participate in their destiny and exercise control over it. The set of economic preferences (Section 4.7) are derived from

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29/ Per contra, it is this insight which makes developed countries and elites in developing countries choose modern technologies to advance their interests.

two value judgements made by the United Nations system: (1) That development is a desirable process; and (2) That a New International Economic Order is essential. Hence, the list of environmental preferences are meant to achieve the objective of harmony with the environment, (i.e., environmental soundness), and the social preferences, the objective of people's participation in, and control over, their future (i.e.,social appropriateness). The economic preferences are intended to achieve, in the context of the developing countries, the objective of development, and in the context of the developed countries, the establishment of the New International Economic Order, which also concerns the relationship between developed and developing countries. Thus, the economic appropriateness of technologies is to be judged by whether they facilitate the process of development and the establishment of the New International Economic Order.

4.12 A note of caution should be sounded here. In recommending preferences for alternative technologies, it is not argued that modern technologies, i.e., the technologies of the developed world, should be excluded in a priori manner, or that alternative technologies should be chosen on emotional grounds. In fact, it may be found through the rigorous decision-making process of going from preferences to choices that some modern technologies may actually quicken the process of development and hasten the establishment of the New International Economic Order. Thus, the detailed exercise of choosing technologies may lead to a particular modern technology being considered the most environmentally sound and appropriate for the concrete circumstances for which the choice is made. But, such a conclusion must be arrived at only after a detailed analysis, and not by assuming that what is most modern (i.e. current in the developed world) is automatically the most appropriate.

4.13 It follows, therefore, that the total package of environmentally sound and appropriate technologies for a particular context (which may be a particular country or the set of developing countries or the developed countries) may consist of a mix of modern and alternative technologies. But, that mix must include a substantial component of alternative technologies if the aim is to avoid the environmental, economic and social consequences described in Section 2.

4.14 This mix is the inevitable result of having to reckon with a very large number of considerations - environmental, economic and social - and being compelled to assign varying weightages to the different preferences. In other words, in the particular environmental, economic and social context, one may have to give far greater importance to some preferences than to others. The whole methodology of this decision-making with regard to the choice of technology is sure to be complex and difficult, and needs a detailed study which is outside the scope of this report.

4.15 In view of the discussion in Section 4.12 and 4.13, it is necessary to persist with the term "alternative technologies", to distinguish them from the modern technologies which are likely to be included in the category "environmentally sound and appropriate". The term "alternative technologies" will therefore be used in the rest of the report to refer to technologies with the preferences listed in Section 4.6, 4.7 and 4.8.

4.16 Attention will now be turned to the implications - environmental, economic and social - of a widespread but not necessarily exclusive, adoption of alternative technologies, and of a substantial, but not necessarily complete, rejection of modern technologies; that is, to the implications of a total commitment to a pattern of environmentally sound and appropriate technologies which is likely to be a mix with alternative technologies constituting a very significant component.

5. ENVIRONMENTAL IMPLICATIONS OF ALTERNATIVE TECHNOLOGIES

5.1 The proponents of the classical strategy of development for the developing countries, i.e., the strategy of increasing growth rates and per capita incomes through industrialization based on modern technologies, "... were largely apathetic to, and even suspicious of, environment as a faddish preoccupation or disease of the rich". 30/

They even took the view that "... all (debate over) environmental problems may ... be potential threats to ... domestic development". 31/

5.2 During this period, the world-wide questioning of the growth model of development has led to demands for an alternative strategy of development. In this strategy, the improvement of the living conditions of the people is considered the central task. And, with this change of outlook, has come the realization that the living conditions of people cannot be improved when the environment in which they live is being degraded and polluted. For, it is precisely in the developing countries that there is "massive destruction of forests, large-scale loss of productive soil through erosion, march of the deserts and other consequences of ecologically unsound land-use practices, and the appalling conditions of life in exploding areas through lack of adequate water supplies, waste disposal and sanitation facilities". 32/

Thus, it has become obvious that if environmental concerns are forsaken, development objectives are inevitably imperilled.

5.3 Nevertheless, the case for alternative technologies in the developing countries has by and large not dealt explicitly with environmental concerns, because the thrust of this case has been primarily socio-economic.

5.4 The socio-economic preoccupation does not mean, however, that alternative technologies are necessarily ecologically unsound. In fact, the opposite may well be true. For instance, by stressing on smallness of scale of production and its dispersal, these technologies produce minimal perturbations on the environment; by emphasizing, for example, multi-cropping and the use of organic fertilizers, they avoid many of the environmental dis-benefits of modern agriculture; by seeking local and renewable energy sources and raw materials, they lead to better resource management; by arguing for the decentralization and dispersal of production particularly to rural areas, these alternative technologies reduce the trend of migration to cities and therefore facilitate the solution of the environmental problems of human settlements; by assigning priority to the basic needs of the poor, rather than to the luxury demands of the rich, alternative technologies necessarily concentrate on products which are polyfunctional, durable and reusable, i.e., resource-conserving products.

5.5 It may be concluded therefore that the alternative technologies proposed as appropriate for the socio-economic development of developing countries have intrinsic characteristics of environmental soundness, by virtue of the preferences built into them.

5.6 In contrast, the converse proposition that environmentally sound technologies are ipso facto socio-economically appropriate, may be patently false in several common situations. For instance, many highly capital-intensive, automated technologies designed for the production for luxury commodities are introduced into developing countries. If these technologies are made non-polluting, low-wasting, based on renewable energy and raw material sources, they will be heralded as environmentally sound. Nevertheless, they will certainly not be socio-economically appropriate because they squander capital in countries where capital is scarce, save labour where manpower is abundant, direct the little employment that they generate towards highly trained urban manpower when poverty in these countries is due to the unemployment of unskilled rural people, etc.

5.7 Of course, it may be argued that by ultimately increasing the ranks of the poor who will through their poverty degrade the environment, these technologies, for all their superficial and direct environmental innocence and purity, are indirectly ecologically unsound via their socio-economic effects. Such a view, however, only exploits the inter-relationship between environmental and socio-economic factors to include all the latter in the former. This standpoint bestows on the term "environment" such an all-embracing purview that it is made to include everything normally considered to be within the domain of economics and sociology. Common parlance does not sanction so pervasive and tenuous a definition - as is clear from the Governing Council's insistence on "environmentally sound and appropriate" technologies, and the UNEP Executive Director's plea that "we must make ecology and economics ... allies ... in evolving an approach to growth". 33/

5.8 Hence, all environmentally sound technologies are not necessarily ipso facto socio-economically appropriate; and appropriate technologies, characterized as they are by socio-economic criteria, are only a sub-set of the entire set of environmentally sound technologies.

5.9 One should mention at this stage an innovative approach to the relationship between ecological and socio-economic criteria for technologies. This approach starts off from what are claimed to be certain unifying principles in ecology. 34/

The first principle relevant to the present discussion is that ecosystems can be characterized by their maturity.

The second principle is that when two ecosystems at different stages of maturity come into contact with each other and begin interacting, the flow of matter and energy is from the less mature to the more mature so that the latter exploits the former and keeps its maturity constantly low.

If one defines maturity in such a way that developed countries are considered more mature than developing countries, and urban concentrations within developing countries more mature than rural areas, then one has an ecological understanding of the fact that developed countries benefit disproportionately from their relationship with developing countries, and that the economic growth of urban areas in developing countries is at the expense of their rural hinterlands. 35/

5.10 Since human beings are essential components of these ecosystems and since men have values, goals and objectives, a new possibility arises. This possibility consists of the "natural" ecological process of exploitation (of the less mature developing ecosystem by the mature developed one) being transformed into a "man-made" ecological-cum-socio-economic process whereby a mutually beneficial interactive process is established.

5.11 This drive to transform the trend of natural ecological processes through conscious intervention always has socio-economic manifestations. For instance, the demand for a New International Economic Order is the expression of a determination to alter the inequality in the centre-periphery relationship between the developed countries ecosystem and the developing countries ecosystem, and the clamour for development is the manifestation of an urge to remove the exploitative aspect of the interaction between the urban and rural ecosystems in developing countries.

5.12 Thus, a purely ecological approach to the interactions between ecosystems at different stages of development only sanctions and ratifies the exploitation of the less developed by the more developed ecosystem. It is essential to inject the socio-economic objectives of development and the New International Economic Order to bring redress to the exploited ecosystems.

5.13 Little needs to be said about the environmental implications of the adoption of alternative technologies in the developed countries, for these implications follow naturally from the preferences (Section 4.6) which characterize these technologies. By emphasizing products designed for durability, easy repair and maintenance, recycling, re-use and multiple use, alternative technologies are inherently consistent with the conservation of resources. Alternative production technologies are intended to facilitate this objective of decreased resource including energy demands because of their stress on renewable and local rather than depletable and imported resource including energy, and on waste minimization as an integral feature in production technology rather than as a pollution-abatement afterthought. At the same time, the conscious attempt to decrease the scale of production and concentrate on services for common, rather than private use, reduces the impact on the environment. Thus, the compatibility of alternative technologies with the environment arises from their intrinsic "softness" or environmental soundness in any context.

6. ECONOMIC IMPLICATIONS OF ALTERNATIVE TECHNOLOGIES

6.1 The economic implications of the selective or extensive adoption of alternative technologies are necessarily different in developing and developed countries.

6.2 Developing countries

6.2.1 The proponents of alternative technology in the context of developing countries have often, but not always, concentrated on the generation of employment, the saving of capital and foreign exchange, the use of local raw materials and energy sources, and so on. In the whole matter of the choice of technologies, detailed analyses have been mainly confined to projects, for example, two ways of producing a single product (e.g., fertilizer), or the appropriate scale of production of some particular commodity (e.g., white sugar).

6.2.2 In the first place, such a compartmentalized or sectoral approach implies an acceptance of the product-mix of the developing countries, i.e., the composition of their total production output. But, the very cause of distorted development may be that this product-mix is skewed in favour of the needs of affluent elites (private automobiles rather than public buses). In such a case, unless there is a basic change in the composition of the gross national product, the deployment of alternative production technologies will prove only a minor perturbation on the scene.

6.2.3 Secondly, an economy is not merely the sum total of discrete projects; it is an interacting system of projects with outputs from one sub-set of projects becoming the inputs for another sub-set and so on. If an economy is biased against development, changes in technology alone will be quite inadequate. Thus, the mere substitution of plants based on modern technology with plants based on alternative technology may in fact further frustrate development. For instance, the capital saved through capital-saving technology in a particular sector may be diverted to a labour-intensive industry producing luxury goods for a small section of the population, and may thus lead to the increase of disparities.

6.2.4 Alternative technologies must, therefore, be seen in the framework of a commitment to the objectives of development, i.e., a commitment to the satisfaction of basic minimum human needs through a process of social participation. Such an objective necessarily leads to the abandonment of growth per se as a socio-economic objective. It is the content of growth that matters as much as its volume, though a higher rate of growth may be - and invariably is - an indirect consequence of not pursuing growth as the main objective. This is because a poverty-stricken population abandons its apathy in favour of conscious participation in the development process when it sees its basic needs increasingly satisfied.

6.2.5 This release of creative energies of a chronically down-trodden majority of the population is assisted by the fact that many small-scale alternative technologies have distinctly smaller gestation times and work to fuller capacities because their infrastructural demands on power, raw materials, transportation, spares, and skills are much less. Thus, they lead to quicker returns on capital particularly if the capital-output ratio of the alternative technology is comparable or better than that of the corresponding modern technology.

6.2.6 Above all, the ability of capital-saving, energy-conserving, labour-intensive alternative production technologies to generate employment in the countryside where unemployment and poverty are acute implies a significant reduction of inequalities and "depolarization" of the dual society.

6.2.7 The adoption of a new product-mix weighted in favour of the needs of the poor also implies the production of goods with a smaller import content, and therefore, foreign exchange component. Other factors also work in the same direction, e.g., the emphasis on locally available raw materials and energy sources, on natural materials rather than imported synthetics, etc. Above all, by stepping off the bandwagon of continuously advancing modern technology, the desperate urge to buy the latest technology ceases, and therefore the associated drain of foreign exchange through technical fees, royalties, etc. becomes unnecessary. All this constitutes the real move towards self-reliance as far as investment and aid is concerned.

6.3 Developed countries

6.3.1 The discussion of the implications of alternative technologies in the context of the developing countries has confirmed once more the intimate interplay of environmental concerns and economic objectives. Attempts to restrict concerns purely to socio-economic objectives (disregarding the environmental context of social change) only results in a deterioration of the habitat and, therefore, to an indirect frustration of the initial (socio-economic) objectives. Conversely, a total preoccupation with the environment (neglecting the human society which pursues its aims and endeavours in that milieu) results in a degradation of human beings who can then ensure their self-interest and survival only at the expense of that very environment. Thus, an obsession with socio-economic objectives with a total disregard of environmental concerns is naive for it leads to irreversible damages to the environment within and in harmony with which those objectives should be realized; and an exclusive concern with the environment neglecting the society that lives in it is reactionary for such an amoral concern leads to the overt or covert approval of current injustices to human beings whose dreams and destinies constitute the only valid and justifiable raison d'être for any interest at all in the environment.

6.3.2 Though the need for a unified environmental-cum-socio-economic perspective is as valid and vital for the developed countries, their proponents of alternative technologies have focussed far less attention on economic objectives than on the threat to the environment and on the erosion of the quality of life for individuals in these countries. The result of this restricted view is the emphasis on environmentally sound technologies (with no questions asked about their economic appropriateness) and the impassioned plea for new lifestyles in which reduced consumption is the main element. A strategy which confines itself to these limited objectives can have undesirable consequences - as may be seen from the following considerations.

6.3.3 The fundamental question regarding environmentally sound technologies for developed countries is the socio-economic framework with which they are to be made consistent. For instance, one can render modern technologies environmentally sound by making them: (a) Pollute less; (b) Minimize and/or utilize wastes; (c) Conserve depletable resources; and (d) Rely on renewable resources. It should be recalled, however, that any technology is designed and developed to suit the prevailing factor prices, in particular, the prices of raw materials and energy. And modern technologies, i.e. the technologies of the advanced industrialized world, have been evolved under an economic order in which, for instance, developed countries obtained raw materials from developing countries at prices which did not escalate at the same rate as the prices of the capital goods sold to the developing countries. Thus, the retention of many modern technologies, however environmentally sound they may be rendered, s tantamount to a consolidation of the prevailing centre-periphery relationships between developed and developing countries and to impeding the achievement of the New International Economic Order. It is quite inadequate, therefore, to ensure that the technologies of the developed world are environmentally sound (low-wasting or non-wasting for example); it is also vital to scrutinize whether they are socio-economically appropriate, i.e., whether they facilitate the type of new relationships between developed and developing countries envisaged in the New International Economic Order.

6.3.4 A large number of steps must be taken to transform this United Nations vision of a new future into a reality. One such step involves reduced consumption levels in the developed countries. It is this realization which has given rise to the belief that all that is necessary is new lifestyles which are not obsessed with the consumption of material goods and services. This is an over-simplified view. Reduced consumption as an isolated economic measure will inevitably result, on the one hand, in the generation of enormous savings seeking new avenues of investment and, on the other hand, in underutilization of production capacity. If the spare investment and production capacity is directed towards an increased military spending and/or a consolidation of the prevailing economic order, then the reduced consumption pattern has only aggravated the situation.

6.3.5 Changes in consumption patterns in the developed countries have meaning, therefore, only in relation to changes in production patterns. The purpose of production, and of the associated technologies, needs as detailed a questioning as the trend of consumption. The point is that modern production technologies were designed to maximize growth, and what needs scrutiny is this very objective of growth.

6.3.6 Alarmed at the environmental impact of the growth-obsessed economies of developed countries, the argument of "no growth" has been advanced. It is clear, however, that this argument for a reduction to zero of the growth rate of developed economies is irrational as long as these economies continue to be based on growth-maximizing modern technologies.

6.3.7 There is, however, an alternative, which is similar to the alternative strategy set out for developing countries. This alternative would be to reject growth as an objective per se, and in its place to pursue the quality of life. The argument is that since the satisfaction of the basic minimum needs is, or can easily become, a fait accompli in developed countries, the economic objective must be to facilitate "... to an increasing degree ... the satisfaction of man's higher needs and aspirations in the fields of culture - music, art, literature, and other forms of individual self-development and fulfilment. These, after all, are the areas in which man achieves his highest levels ... in human terms". 36/

6.3.8 The details of the course to this new future have yet to be worked out, but some features are reasonably certain "In practical terms, ... (it) will mean a redesign of industrial systems" 37/ and therefore of technologies. If alternative technologies, characterized by the preferences listed in Section 4.6 to 4.8, are adopted as a major component of the new mix of technologies, several implications follow. Firstly, instead of the current criterion of economic rationality at the level of each productive unit, the emphasis will shift to a broader rationality for society as a whole. This may involve acceptance, in the larger interests, of lower productivities of capital and labour, i.e., of lower output/capital and capital/labour ratios. Secondly, alternative product technologies may imply less emphasis on sales turnovers than on the durability, re-use, recycling, and resource-consumption of products. Finally, alternative technologies of production imply a stress on decreased resource-demands waste minimization and utilization, and proximity of production to consumption. These production technologies will also mean a higher priority to increasing quality and satisfaction in the work process than to maximizing productivity.

6.3.9 If growth per se ceases to be an economic objective for the developed countries and if alternative technologies are deployed widely, it necessarily means a decreased consumption of resources. Further, since these resources largely come from developing countries, it follows that there might be a diminution of the volume of raw materials trade between developed and developing countries. At the same time, the catalysis of the development process in developing countries may lead to the dispersal of raw-material processing centres to these countries, and perhaps to greater trade between them. Thus, one can forsee changes in the volume, pattern and directions of international trade, but these changes are all likely to be consistent with the equity envisaged by the New International Economic Order.

6.3.10 In the framework of the above discussion, it is clear that the classification of countries into developed and developing countries leads to the questionable view that the development process is over in the developed countries and remains incomplete only in the developing countries. Such a classification also suggests that the only objective of development is the satisfaction of basic physical needs, and once these needs are satisfied, the country is deemed "developed". Seen thus, development is a process which needs to be carried out only in the developing countries, though it may well be a global concern. The philosophical predicament is worse, because the classification does not lead to a perspective for

developed countries. In fact, in implies that the current economic objectives of these countries with their overriding emphasis on growth can persist provided that they are made consistent with concern for the environment and for developing countries.

6.3.11 If, however, the objective of development is stated in terms of human needs, which are not merely physical, but also cultural and social, then the development process is not over in the developed countries. And from this larger view of development, industrialized countries too are developing; indeed, they are at a stage of development in which the conventional obsession with growth maximization and with increasing the consumption of goods and therefore resources has to be abandoned. Further, this new perspective of development for industrialized countries hinges on a new pattern of technologies in which alternative technologies must be a major component.

6.3.12 Thus, development is a global process, not merely a process confined to what have been termed "developing" countries. It is only when development is viewed with this larger perspective that the so-called "developed" countries acquire perspectives which harmonize their relationships with the developing countries and lead to the establishment of the New International Economic Order.

6.3.13 Hence, the economic implications of alternative technologies are global because these technologies constitute the basis of a global development process which takes different forms in the affluent and poor countries and leads to a new pattern of relationship between them. Basically, however, the implications follow from the intrinsic tendency of alternative technologies to diminish inequalities between and within countries.

7. SOCIAL IMPLICATIONS OF ALTERNATIVE TECHNOLOGIES

7.1 Developing countries

7.1.1 The most important social implication of alternative technologies in a developing country is that they would tend to stem, and reverse, the polarization into a dual society. The capital-saving characteristic of these technologies ensures a more even dispersal of the scarce capital, and a more even development; whilst their ability to generate employment in poverty-stricken rural areas reduces inequalities. In particular, the decentralization and dispersal of production to rural areas will facilitate the self-reliant and endogenous development of villages, and prevent metropolises growing at the expense of villages. Once rural society realizes that the means and the ability to achieve *development* lies within itself, the consequent release of social energy will have dramatic implications as far as social participation is concerned.

7.1.2 This whole process of catalyzing social participation will be assisted by the new emphasis in alternative product technologies on goods and services directed towards the basic needs of the masses rather than towards luxury consumption by the elite. This new emphasis will curb the current tendency of the western-oriented lifestyles of the elite corrupting the poverty-stricken masses with unsatisfiable desires. If alternative technologies are designed for a simple life, at least that simplicity will be shared by every member of society. Such a shared austerity generates far less social tensions than conspicuous consumption by a small elite in the midst of utter deprivation of the vast majority.

7.1.3 A whole sub-set of alternative technologies are intended to be evolved from traditional crafts and practices through the application of the methodology and accumulated knowledge of science. In addition, most alternative technologies will be deliberately designed to forge organic links with traditional skills and customs. Such technologies, therefore, are likely to blend far more smoothly into the fabric of social life than modern technologies transferred from alien settings which disrupt, rather than transform, traditional social structures.

7.1.4 Above all, alternative technologies by dispersing employment-generating productive units to the villages are likely to reduce drastically the sequential process of rural impoverishment, migration to cities, uncontrolled urbanization and generation of slums. In so far as this process is a major cause of social tensions in cities, these technologies will prove a crucial instrument for building a harmonious society.

7.1.5 Another social effect involves the repercussion of alternative production technologies on human settlements. The decentralization of production and its dispersal to the villages implies the growth of productive activity in the countryside. But, any productive activity (other than agriculture) causes concentration of people. Thus, one can forsee an increase in the population of agro-industrial human settlements - the villages of the future - and for the reasons given in Section 7.1.4, the reduction of the sizes of cities. In other words, alternative production technologies imply alternative patterns of human settlements. This is likely to mean an increase in the opportunities for social life in villages, and in the utilization of such opportunities in cities.

7.1.6 The long term social implication of the widespread deployment of alternative technologies in developing countries is that these countries can avoid the path followed by the developed countries. That path which involved a wholesale reliance on modern technologies has led to such serious environmental, economic and social effects that a major rethinking is now in progress. This may result in the redefinition of social objectives in those very developed countries along lines to be discussed below. In that case, developing countries will not be putting back the clock of history by adopting alternative technologies; rather they will be advancing directly to a type of society to which the developed countries also must converge after going through a painful era of dependence on modern technologies. In this sense, developing countries are in a more fortunate situation - by not inheriting a gigantic, complex, unwieldy industrial structure based on modern technology, they have far greater flexibility to build an environmentally sound and appropriate society.

7.2 Developed countries

7.2.1 The far-reaching social implications of deploying alternative technologies in the developed countries are associated with:

(a) Their emphasis on goods and services designed to enhance the quality of individual and social life;

(b) Their quest for productive units to suit congenial human settlements rather than vice versa;

(c) Their concern for production processes which educate, develop and elevate workers;

(d) Their stress on increasing social participation and control.

7.2.2 Alternative product technologies are directed towards the satisfaction of human needs, rather than the fulfilment of market demand. Their inherently inequality-reducing tendency implies a diminution of the social stresses and tensions arising from underprivileged sections in developed countries feeling deprived and dispossessed. The whole process is synergistically facilitated by the new emphasis on the quality of life rather than the consumption of goods, i.e., on lifestyles less obsessed with consumption than with the higher values.

7.2.3 Alternative human settlements technologies stipulate that the size and distribution of productive units must depend upon whether they enhance the conviviality of individual and social life. The implication is that production technologies must be made appropriate for human settlements, rather than vice versa. Productive units must be fashioned to suit man, rather than man being shaped to suit factories.

7.2.4 All this is unlikely to cause profound changes in the urban-rural population ratio in developed countries, but alternative technologies - as pointed out earlier - imply alternative demographic distributions, in particular, a changed mutually beneficial relationship between town and country.

7.2.5 The concern of alternative technologies for increasing craftsmanship, creativity and individual development in the work process and for decreasing the mass production, automation, and mindless routine (characteristic of modern production technologies) implies a new approach to "work" and "leisure". Specifically, it means a blurring of the prevalent rigid distinction between them.

7.2.6 Alternative production technologies are very likely to be less efficient (for example, in terms of capital-output ratio) than modern technologies, because their development has been guided by considerations more humane than efficiency. Nevertheless, they are certain to be more than capable of meeting social needs of goods and services. The implication is that there will be spare production capacity. One option here is to adjust the efficiencies of production technology to necessitate a "full working day" for producing enough for social requirements. But, the far more promising option is a new approach to the division of the individual's life between rest, work and leisure. The implication is shorter working days. But, such a move has to be coupled with alternative technologies for leisure in which people are players and participants rather than spectators and participants.

7.2.7 At the same time, the preference for production on a smaller scale implies a greater control by workers and the community over the goals of production and over the means of achieving these goals. Smaller productive units also mean greater flexibility in altering the product-mix, and therefore, greater social control over whether the products correspond to their needs. This may differ radically from the current situation in developed countries where the larger the size of the productive unit, the less flexible its product-mix and therefore the more it manipulates and fashions demand.

7.2.8 The emphasis in alternative technology on production for local consumption implies the establishment of a nexus, rather than the prevalent dichotomy, between production and consumption. Such a nexus will not only have effects on the structures of productive units and settlements, but also on the percentage of the population now engaged in services and administration. The latter effect arises because the greater the gap between the production source and the consumption zone, the greater the burden on transport and distribution. Thus, alternative technologies of production and consumption implies a shift of people away from services and administration.

7.2.9 Obviously, the social implications of alternative technologies in the developed countries are profound. One has to rest content here with an impressionist sketch of the type given above. A more detailed picture requires sustained work for visionary sociologists who are not satisfied with interpreting the world, but are commited to changing it.

8. SCIENTIFIC IMPLICATIONS OF ALTERNATIVE TECHNOLOGIES

8.1 Developing countries

8.1.1 Despite the recent surge of interest in the development of alternative technologies, very few of them are available "off-the-shelf". There are three reasons for this lacuna: (1) The task of developing these technologies is not trivial; (2) The indigenous research and development systems have not bothered themselves with these technologies; and finally (3) They are not in vogue in the developed countries. An elaboration of these points will now be made.

8.1.2 Invariably, alternative technologies have been confused with low or primitive technologies. This is because too often the advanced character of a technology has unfortunately been adjudged with the trivial criterion of scale of production, whereas in fact it should be determined by the sophistication of the scientific and engineering thinking that goes into the research and development.

The general conclusion is that alternative technologies are certain to be "advanced technologies". Thus, the demand for new approaches to production engineering based on minimizing capital, energy, scale and skills cannot be satisfied without a mastery engineering. And, if product quality is to be ensured, one cannot just adopt the quality control procedures

used in the developed countries because these measures have been specifically designed for larger-scale industry. It is vital, therefore, to evolve radically new quality control techniques compatible with decentralized, small-scale production, involving people with less industrial skill than in the developed countries. Again, an emphasis on locally available materials requires advances in the science of many materials that are not commonly used in modern technology; hence, new applications of materials science are required. And, attempts to discover the scientific basis of traditional technologies requires sophisticated approaches.

A necessary consequence of this picture of alternative technologies is that they must be developed from as sound a base of fundamental science and basic engineering as is required for modern technology. The importance of this viewpoint must be seen in the context of well-meaning but dangerous advice from experts that developing countries should not invest in basic research. If such advice is acted upon, the result would be highly detrimental to the development of alternative technologies.

The foundation of a vigorous technology is a flourishing science. But the little science that there is in developing countries today derives its emerging areas of research, its trends and fashions, its stream of ideas and inspiration, its assessment of work and personnel, its mentors and advisors, its guides and experts, and its experimental techniques and instruments, from the developed countries. It is looking to these countries for its criteria of excellence and its source of recognition. This outward-looking character of science in developing countries has become the main inhibiting factor in harnessing science to development.

Meanwhile, the technological institutions in these countries have been as hypnotized by the technological preoccupations of developed countries. Abstruse theory, urban problems, problems of large-scale industry - these are the only major concerns of technological institutions in developed countries. In other words, there has been scarcely any interest at all in the development of alternative technologies. There are various factors responsible for this disinterest in technologies relevant to development. Firstly, an inevitable consequence of the polarization into a dual society is the absorption of scientists and engineers into an elite which is divorced from the lives of the poor, and, therefore, secluded from an understanding of their needs and problems. Secondly, the lure of recognition from the developed countries and the identification of modernity with the concerns of these countries results in a view that alternative technologies are not sufficiently glamorous, avant-garde and at the frontiers of advance.

This situation is unfortunate, because the development of alternative technologies requires an advanced multi-disciplinary approach, and such an approach requires the concentrated effort of the best institutions in the developing countries.

8.1.3 In the absence of such an effort, the only recourse is to transfer alternative technologies from the developed countries. There are, however, some problems with this technology transfer approach. Firstly, the technologies of the developed countries have emerged from a set of preferences which is precisely opposite to those characterizing alternative technologies (Sections 4.6 to 4.8). Thus, alternative technologies are rarely available ready-made in the developed countries. Secondly, if they are available, their social acceptability in the totally different contexts of developing countries must be carefully assessed because the subtleties and variations of these contexts are usually ignored in the research and development process. Hence, transferred technologies often turn out to be inappropriate technologies. Thirdly, when alternative technologies are transferred from the developed to the developing countries, the process is invariably excessively expensive because experts are paid salaries at the rates prevalent in the rich developed countries. Finally, the technology transfer process is often uncertain, artificial and externally sustained.

8.1.4 A sure, natural and endogenous approach would consist of the development of alternative technologies within the developing countries. In fact, a commitment by the educational, scientific and technological institutions of the developing countries to alternative technologies must form a crucial part of the overall commitment to the socio-economic objective of development. If such a commitment is made by these institutions, then there are bound to be several important implications.

8.1.5 A most important weakness of R & D institutions in developing countries has been in the aspect of the innovation chain concerned with scaling-up. But the key feature of alternative technologies is that they aim at a minimization of scale. Thus, the weakness of these R & D institutions vis-a-vis large-scale technology vanishes vis-a-vis the mini alternative technologies. These institutions can therefore grapple from a position of strength with the task of developing alternative technologies.

8.1.6 Since expenditure on R & D rises more than proportionately with the scale of the ultimate production units, much smaller funds are required for R & D on the alternative technologies of scaled-down, dispersable, miniaturized production units. In other words, far greater returns can be realized from a given R & D expenditure by a developing country if it turns away from modern technologies to alternative technologies.

8.1.7 At the same time, a commitment to alternative technologies will compel the educational, scientific and technological institutions of developing countries to turn away from the developed countries and towards the local people and their problems. This attempt to strike native roots is bound to have an invigorating influence on science, and perhaps lead to its exhuberant growth. Alternative technologies will also bring scientists and technologies into contact with the countryside and the vast majority of the population. This will have a mutually educative influence. And in the long run, this influence alone will resolve the inevitable problems of language and communication characteristic of the present dual society. It is also this contact which will, on the one hand, bring science and its methodology to the masses, and on the other hand, release their creative energies for the development of non-elitist science and to technology.

8.1.8 Finally, indigenous educational, scientific and technological institutions, stimulated by the challenge of local problems and inspired by the vision of true relevance, are bound to grow and proliferate. The differences in their milieus will guarantee their uniqueness and individualities; the similarities in the problems and surroundings will motivate interaction and collaboration. And when this happens in all developing countries, there will begin a process of genuine collaboration between the educational, scientific and technological institutions of these countries which is a sure basis of the New International Economic Order in history.

8.2 Developed countries

8.2.1 In so far as alternative technologies involve a totally different set of environmental, economic and social preferences, a vast new perspective opens before the educational, scientific and technological institutions of developed countries. For instance, deliberate strategies of decreasing demands of exhaustible resources and shifting to renewable resources, of reducing energy inputs for production and consumption, of increasing product life, etc., all imply major R & D challenges.

8.2.2 These challenges will be accentuated by the new objectives placed before production engineering. In these new objectives, the main theme will be a new role for the worker in which he is not reduced to an automaton subordinate to machines. Thus, a radically new approach will be required in order to resurrect man for a central role in production and consumption. A production engineering to fulfil these objectives will have to integrate its endeavours with other disciplines, e.g., psychology, in new interdisciplinar approaches.

8.2.3 Fundamental research, thus far the step-child in any crisis of R & D funding, will really come into its own. Longstanding intellectual challenges will be given a pre-eminent position not because success in tackling these challenges will ultimately lead to growth, productivity, markets and profits, but because they are essential to the quest for a higher life.

8.2.4 Hopefully, with the blurring of the distinctions between work and leisure and a widespread emphasis on the creative educative development of workers, there will be an increase in the participation of lay people in the theoretical and experimental quests of science and technology. Indeed, that is the objective of the shift away from the consumption of goods to the participation in the enhancement of the quality of life.

8.2.5 Above all, a vast new perspective arises in connection with the development of technologies appropriate to the developing countries. This task involves designing technologies for totally different factor proportions to those customary and axiomatic to modern technology. The new aim will not be, for example, to automate, save labour and mass produce irrespective of the capital investments and energy consumption, but to adjust in the very process of development to the factor proportions of capital, labour and energy of particular developing countries. A whole spectrum of appropriate technologies await development - and this is an enormous task.

8.2.6 Thus, the adoption of alternative technologies in developed countries will lead to stimulating new directions in science and technology.

9. CONCLUSION

9.1 A detailed report has been presented above on several essential aspects of a conceptual framework for environmentally sound and appropriate technologies. In particular, the following aspects have been treated:

(1) A synthesis of the various criticisms of modern technology in the context of developed and developing countries;

(2) A listing and brief description of the large numbers of terms proposed to designate patterns of technologies alternative to modern technology;

(3) A discussion of the relationship of the various terms to the concept of environmentally sound and appropriate technologies;

(4) An elucidation of the concept of environmentally sound and appropriate pattern of technologies stressing that such a pattern is likely to be a mix of modern technologies and a substantial component of alternative technologies the latter being characterized by a list of preferences; and

(5) An exploration of the environmental, economic, social and scientific implications of the adoption in developed and developing countries of alternative technologies.

Environmentally sound and appropriate technologies are to be defined in terms of the environmental objective of ecological soundness, the economic objective of reduction of inequalities between and within countries, and the social objective of social participation and control, and it is argued that these objectives are consistent with the United Nations objectives of development and the New International Economic Order.

Notwithstanding the understanding outlined above, two major issues remain to be resolved.

9.2 The first arises from the complexity of the task of operating the preferences characterizing the pattern of environmentally sound and appropriate technologies. In particular, how is the mix of modern and alternative technologies to be determined? How are weightages to be assigned to the various preferences? Can generalized selection rules be evolved for the choice of technologies?

9.3 The second issue concerns the methodology for the development and diffusion of environmentally sound and appropriate technologies. Since educational, scientific and technological institutions today are almost wholly absorbed in the development of modern technologies, what transformations in these institutions and what new institutions are required for the development of the alternative technologies which will form a significant component of the new pattern of environmentally sound and appropriate technologies? After development of these technologies, what institutional mechanisms are necessary for the diffusion of these technologies?

9.4 These issues will be taken up for analysis in the subsequent and immediately following phases of the United Nations Environment Programme project.

9.5 One cannot over-emphasize the importance of the whole concept of environmentally sound and appropriate technologies. To take insufficient cognizance of the ecological soundness and socio-economic appropriateness of technologies is tantamount to running the risk of environmental degradation and to jeopardizing development and the achievement of the New International Economic Order. Thus, every concern for society and for the environment in which society persists must find expression in the choice of technologies. This means that discussion of the choice of technology must be an inseparable part of any discussion either of the environment or of socio-economic objects. The role of the United Nations Environment Programme on technologies is to strengthen and amplify that awareness where it exists, and to initiate and generate that awareness where it is absent.

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